A

NEW AND CONCISE

METHOD OF HAND-RAILING,

—

UPON CORRECT PRINCIPLES;

SIMPLIFIED TO THE CAPACITY OF EVERY

PRACTICAL CARPENTER:

ALSO,

A FULL DEVELOPMENT OF THE CYLINDRIC SECTIONS,

AS APPLIED TO

NICHES, GROINS, DOMES,

AND ALL THE

Most Intricate Parts of Carpentry.

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PREFACE.

THE principles of Hand-Railing, as treated of by many authors, (although in a very able manner) require for their demonstration a degree of mathematical knowledge, which, if not of a very high order, is often beyond the capacity of the Carpenter, who wishes to apply them to practice. The quantity of lines required for the development of a face mould, which so generally embarrass the mind of the student, have been entirely dissipated by the introduction of the Concentric Ellipsograph, invented by the author, and for which he has the satisfaction of being honored with the approbation of a number of scientific persons, as being the most correct and simple method of obtaining the cylindric sections, ever before discovered. One of the important uses of the Concentric Ellipsograph is the facility which the uninstructed artizan perceives in its application to obtain the various curves required in carpentry. There has been shown on most of the plates, one face mould, obtained on the most improved old method, and one on the new; for the latter, the heights taken from the falling moulds and applied to the chords of the plan, to get the pitch of the face moulds,

being all that is required; the form of the face mould is procured by the instrument. The Carpenter will perceive that when he can draw a falling mould for any stairs, the greatest difficulty is overcome. In furnishing such drawings and explanations as are connected with the following treatise, it has been the object of the Author to be understood by the most inexperienced; in doing this he has made occasional sacrifice of that diction and orderly arrangement which a learned person would prefer.

PLATE I.

TO DRAW THE SCROLL OF A HAND-RAIL.

In Fig. A. let *d*, *c*, be the width of the scroll; divide the width into nine equal parts; take one of these parts and place it from *c*, to *a;* or *d*, to *b:* draw the line *a*, *b*, and the diagonal line *c*, *b;* come down five parts from *d*, and draw a line at right angles to *d*, *c;* bisect this line, and draw a semi-circle, from the angle *x*, and through the point where the semi-circle crosses the diagonal line at *o*, draw a line to meet *d*, *c;* draw another line from the angle at *5*, through the intersection of the semi-circle and diagonal at *o*, and produce it to an indefinite length, from the point where the line *x*, *o*, touches the line *c*, *d;* draw a line at right angles to *c*. *d*. to meet the line 5. *o*. and continue to draw lines at right angles to each other from the points where they intersect the cross lines, until the right number of centres are acquired. Fig. E. shows the centre's full size for practice and laid in the same position as those of Fig. A. and regularly numbered as the operator progresses to draw the scroll, the centre at 1, draws from *b*, round to *e;* the centre 2, draws from *e* to *c;* the centre 3, draws from *c* to *f;* the centre 4, draws from *f* to *g;* the centre 5, draws from *g* to *h;* and the centre 6, draws from *h* to *i*, which completes the convex side of the scroll. Set the width of the rail in from *b* to *m*, and begin with the same centre 1 as drew the convex side, to draw the concave side, and progress with the same centres until the scroll is completed. The dotted lines shew the riser, string and projection of the nosing drawn by the same centres as the scroll.

TO DRAW THE CURTAIL STEP.

Fig. C. Take the same centres as for the scroll. Set the distance the string and riser is in from the scroll and the projection of the nosing, and draw them equidistant from the scroll, which will give the form of the curtail step and riser.

TO DRAW THE FACE MOULD FOR THE SCROLL.

Place the pitch board as in Fig. B, and draw lines at right angles to the bottom of the pitch board, at discretion; then take the length of the line *a*, 7, on the longest side of the pitch board, and lay it down at *a*, 7, in Fig. D; place the different divisions of the line *a*, 7, on Fig. B, on the line *a*, 7, Fig. D, and draw lines at right angles to it, to an indefinite length; then take the different lengths of the lines on each side of the pitch board *o*, 7, Fig. B, and place them respectively on the lines in Fig. D, as the letters and numbers indicate, and through those points transferred from Fig. B, trace round the form of the face mould.

TO FIND THE FALLING MOULD.

Fig. G. Lay down the pitch board and divide the height into six equal parts; draw the line 1, 6, equal to one of those parts from the bottom of the pitch board. This allows for the level part of the eye of the scroll. The distance of the line *b*, from *c*, is from the face of the riser to the beginning of the twist. Take the length round from *a* to *x*, on Fig. B, and apply it to Fig. G, from *b* to 6″. Divide the level of the scroll from *o* to 6″ into any number of equal parts, and near about the length of the rake of the pitch board into a like number of parts, and get the curve of the top edge of the mould, by intersecting lines; then draw another line parallel to the top, to the depth of the rail, and the falling mould is completed. The outside falling mould may be found in the same way by taking the length of the curve part of the concave part of the rail, and applying it in like manner as for the inside mould, but this one mould will be found sufficient for general purposes.

PLATE II.

TO FIND THE MOULDS FOR CONSTRUCTING A RAIL FOR A STAIRS WITH A LEVEL PLATFORM.

Commence by laying down the plan of the rail, Fig. 1, with as much of the straight part of the rail attached to the curve part as may be desired; find the stretch out of the convex side of the rail by dividing the radius of the circle from the centre to 4. into four equal parts. Come down three parts and from it draw a line to touch the extreme of the diameter, and produce it to an indefinite length. Draw a tangent parallel to the diameter line, to meet the indefinite line, and from where they intersect to the point C. will be equal to the length of the quarter circle. Take this length and lay it off on each side of the centre plumb line, Fig. 2, as E. F.; apply a pitch board at each end of the stretch out, one supposed to be on the last step of the first flight, and the other elevated on the first step of the return flight. Join the angles of the pitch boards that are nearest to each other by the line *u. u.* Curve off the angles, either by the common method of intersecting lines, or with the compasses, and the bottom edge of the falling mould will be completed. Draw a line parallel to the bottom, for the top of the mould; place the length of the straight part of the rail outside the stretch-out diameter lines, from F. to V. and E. to *g;* from V. *g.* raise plumb lines to cut the falling mould and square off the ends of the falling mould, inside those plumb lines and the falling mould will be completed.

TO FIND THE FACE MOULD.

At Fig. 2. bisect the centre plumb line from 3. the top of the falling mould to the bottom edge, and through the centre draw the line *o. z.* at right angles to the falling mould; bring down the corners of the falling mould, as shown by the dotted lines, to touch the convex side of the plan of the rail, Fig. 1. Then draw them to the centre, find the centre of the thickness of the plan of the rail, as shown by the dotted line, from each end of the centre of the rail; draw the dotted chord line; and parallel to it, draw another line to

touch the lowest corner of the rail, as *x. s.*; draw a line from the centre, at right angles to the two chord lines, to cut the convex side of the rail, and through this intersection draw a line from the point 3″ and produce it to the tangent stretch-out line; from it raise a plumb line to the top of the falling mould. This will be the centre height to apply to the centre height of the face mould. Raise plumb lines from the chord line *s*, on Fig. 1, at *o. o.* and *g. g.*; take the heights from the falling mould, *o. o. b.* 2. and *g. g.* and apply them to the corresponding heights from the chord line, Fig. 1; these will be the pitch heights for the face mould; through the two outside heights draw the line *w. w.* From the centre height at 2″ as a centre, describe a circle to touch the pitch line, *w. w.*; let fall the tangent dotted line, *r.* 5″, to cut the chord line at 5″; draw the line *e″* 5″ through the centre height at 2″, draw a line at right angles to the pitch line *w. w.*, take the length of the line *e″* 5″ and apply it to the right angled line from 5. to *e.;* draw a line from the point where the centre height cuts the pitch line *w. w.* to the length of the right angled line; and it will be the governing ordinate. Take the length of the governing ordinate in the compasses, and with *e″* as a centre, describe a segment to cut the chord line at 5″; draw a line from this intersection to the centre that produced it at *e″* and this line will be the governing ordinate for the plan of the rail. Draw any number of ordinates parallel to the governing one, from the chord line, to cut the convex side of the rail, and where they intersect the convex side of the rail, raise lines parallel to the pitch heights to cut the pitch line *w. w.*, and let them fall to the concave side of the rail. Where they cut the concave side of the rail, draw lines parallel to the chord line to touch the ordinates, as *k. l. m. n. p.* From the points where the plumb lines cut the pitch line *w. w.*, draw ordinates parallel to the governing one, to an indefinite length; take the lengths of the ordinates on the plan from the chord line to the convex side of the rail, as *x′*, *y′*. 2′, *b′*. 3′, *c′*. 4′, *d′*. 5″, *e″*. 6′, *b′*. 7′, *g′*. 8′. *h′*. 9′, *i′*. *s′*, *t′*. and apply them to the corresponding ordinates for the face mould; through these points trace the convex side of the face mould, take the lengths of the ordinates on the plan from the convex side of the rail to the points where the parallel lines to the chord line cut the ordinates, as *d′*, *r′*. *l′*, *e′*. *m′*, *b′*. *n′*, *g′*. and *p′*, *h′*. and apply them to the corresponding letters on the face mould; through those points trace the concave side of the face mould, draw a line from 1. to *y.*, to cut off the end of the face mould, and a line from *j.* to *t.* to cut off the other end. The line *&. b.* shows where the straight part joins to the curve part, which completes the face mould. At A. shew the pitch heights for

the upper wreath, taken from the corresponding heights at B. of the falling mould. The chord line *c. d. e.* at A. is drawn different from that of the other chord line, it being drawn parallel to the centre of each end of the rail piece, but the chord line, *c. d. e.* at A. is drawn to touch the lowest corners of the rail piece, and the upper pitch height taken from the line *e.* 5., at B. of the falling mould, instead of being taken from the line V. in the usual way. This arrangement is more simple and where the pitch is not great, will be found sufficiently correct. The lines shown at A. will be sufficient to obtain the face mould by using a concentric ellipsograph, an instrument which will be hereafter described, and the method of applying it. In this plate the lower face mould will answer for the upper wreath, because the easings and the pitch of the lower and upper parts of the falling mould correspond with each other.

PLATE III.

TO FIND THE FACE AND FALLING MOULD FOR A STAIRS WHICH HAVE THE STEPS THROWN INTO THE CIRCULAR PART OF THE STRING.

Commence by laying down the plan of the rail, with as much of the straight part attached to the circular part as may be desired, set in the centre baluster *o.*, determine on the width of the tread and set in the balusters around the centre of the rail from *o.* equal to half of the tread, draw the riser on each side next to the diameter in the straight part of the rail *x. x.* Measure up from the risers, *x. x.* the width of the tread and draw the risers, *u. u;* curve off their ends in the circular part of the string, at discretion, observing that the termination of the curves of the risers tend to the centre of the opening; the dotted line outside the rail shows the projection

of the nosings. The stretch-out is obtained by the same method as at Plate II., by dividing the radius into four equal parts, and measuring down from the diameter line to the point 7, equal to seven of these parts. From the point 7. draw lines to touch the extremities of the diameter at T. V. and produce them to cut the tangent at *t. t.*, then the distance from *t. t.* will be equal to the length around the semi-circle. The stretch-out of the concave side of the rail is found precisely in the same way for the outside falling mould, which is represented in the elevation, Fig. 2., by the dotted lines.

To draw the inside falling mould, determine on any base line, as M, N. Carry up plumb lines from the stretch-out *t. t.* to an indefinite length, take the straight part of the rail on Fig. 1. from V, to T. and place it outside the diameter stretch-out line from R. to K. and P. to L.; raise plumb lines from K. L. to an indefinite length; place in the height rod, and draw a pitch-board the same distance outside the stretch-out line R at the bottom, that the riser is outside the diameter line in the straight part of the rail fig. 1. Also, place a pitch-board at the top, the same distance outside the stretch-out line P, that the first riser is outside the diameter at Z, in the straight part of the rail fig. 1, on the return flight. Draw the hypotenuse of the pitch-boards and produce them to the stretch-out lines P, R. at *w, w;* draw a line from *w* to *w*, ease off the angles, and the bottom edge of the falling mould will be obtained. Draw a line parallel to the bottom edge; for the top, square off the ends inside the plumb lines K, F, and A, L, and the inside falling mould will be completed. Proceed by the same method to form the outside falling mould, only instead of taking the stretch-out of the convex side of the rail, take the stretch-out of the concave side; the outside falling mould is indicated by the dotted lines. The pitch heights for the face mould are always taken from the inside falling mould, the principal use of the outside falling mould being to square the rail, this being the only correct method by which it can be done.

TO DRAW THE FACE MOULD Fig. 3.

Let G represent the semi-plan or half of fig. 1, of which S is the centre. Draw the dotted chord line from the middle of the thickness of each end of the rail, and parallel to it draw another chord line to touch the lowest corner of the rail piece; raise plumb lines from the chord line, as K F, H C, and also from the centre S to an indefinite length; take the distance *a*, round the convex side of the rail from *h* to *b*, and place it in fig. 2, from R to I, and P to O. Raise

plumb lines from I O, to cut the top of the inside falling mould; divide the centre line into two equal parts where it cuts the top and bottom edges of the falling mould, and through the centre draw a line at right angles to the falling mould; where this line cuts the two edges of the falling mould, bring them down parallel to the centre line to touch the convex side of the rail fig. 1. From thence draw lines to the centre, and where those lines cross the centre line of the rail, they give the points from which the dotted chord line is drawn; this space on each side of the centre line allows for making a butt joint. Take the heights H C, I E, K F, Fig. 2, and apply them to the pitch heights H C, I E, K F, Fig. 3. Draw a line through the points C F, and this line will be the pitch of the face mould. From the point E as a centre, describe a circle to touch the pitch line; bring down the tangent dotted line to cut the chord line, from this intersection to the centre height at *b*, on the convex of the rail; draw the line 9 *b*, from the centre height at E; draw a line at right angles to the pitch line; take the length of the line *b* 9 in G, and apply to the right angled line; from the pitch line to *b*, draw a line from the point where the centre height cuts the pitch-line to the point *b*;—this line will be the governing ordinate for the face mould. Take the length of this line with your compasses, and at the point *b* in G, as a centre, describe a segment to cut the chord line as at 5; from 5 to the point *b*, draw a line—this line will be the governing ordinate for the plan G. Draw any number of ordinates parallel to the governing one to cut the chord line, and the convex side of the rail. Carry up those points *a*, *b*, *c*, *d*, *e*, *f*, *g*, *h*, *i*, by lines parallel to the pitch heights, to cut the pitch line at 1, 2, 3, 4, 6, 7, 8, and bring them down to cut the concave side of the rail; from those points draw lines parallel to the chord line, to meet the ordinates at *l*, *m*, *n*, *s*, *p*. Carry up lines from the corners K. *i*, *x*, *a*, of the rail piece G; to meet the pitch-line, from *x*, 1, 2, 3, 4, 6, 7, 8, 0, draw lines parallel to the governing ordinate, to an indefinite length; take the lengths of the ordinates in G, from the chord line to the convex side of the rail, and apply them to the corresponding ordinates from the pitch-line; through those points *a*, *b*, *c*, *d*, *e*, *f*, *g*, *h*, *i*, trace the convex side of the face mould, then take the lengths of that part of the ordinates in G from the convex side of the rail *c*, *d*, *e*, *f*, *g*, to the points *l*, *m*, *n*, *s*, *p*, and apply them from the corresponding letters on the convex side of the face mould, to the points *l*, *m*, *n*, *s*, *p*, on the concave side; through those points trace the concave side of the mould; make *o*, *i* and *x*, *a* equal to *o*, *i* and *x*, *a* in G; draw lines from the concave corners to the points *i*, *a*, and the face mould will be completed. The line *r*, *h* shows where the straight part

of the rail commences from the circular part. Fig. 4, shows the face mould for the upper wreath, the pitch heights J, A, Y, B, D, corresponding with the heights taken from the falling mould J, A, Y, B, D; the chord line J, D, is taken from the plan fig. 1. Fig. 4 shows all the lines that are necessary when the face mould is to be drawn with an ellipsograph.

PLATE IV.

TO DESCRIBE THE MOULDS FOR A HAND-RAIL FOR A STAIRS WITH A LEVEL LANDING, AND ONE RISER CUTTING INTO THE CIRCULAR PART OF THE STRING.

Draw the plan of the rail fig. 1; determine on the width of the steps, and set the ballusters around from each side of the centre one *o*, in the middle of the rail, equal to half of the tread; draw the riser nearest to the diameter in the straight part of the rail; set up the width of the tread, and draw the riser in the circular part; curve off the end of the riser to suit the balluster. To draw the inside falling mould, find the length of the convex part of the rail from V around to W, and lay it on any base line from X Y; take the straight part of the rail on the plan from U to V, or T to W, and place it on the base line from Y to F and X to U; draw lines from the points U, X, Y, F, to an indefinite length, perpendicular to the base lines. Set in the pitch-board on the base line from Y, the same distance the front of the riser is in the straight part of the rail from the diameter line on fig. 1. Draw the level part of the rail *o*, *o''* to the heighth required, to meet the stretch-out diameter line. Carry up the line of the hypotenuse of the pitch-board to meet the stretch-out diameter line Y at .P Join P, O'', ease off the angles, and the bottom edge of the falling mould is obtained. Draw a line parallel to the bottom for the top edge; square off the lower end inside

the line F, L. Carry up the centre line to cut the top of the falling mould. Bisect the centre line where it cuts the bottom and top of the falling mould, and draw the joint through the centre at right angles to the falling mould; bring down lines from each corner of the joint to touch the convex side of the plan fig. 1; from thence draw lines to the centre; draw the dotted line *m*, *n*, and parallel to it draw the chord line to touch the lowest corner of the rail. Draw a line from the centre at right angles to the chord line, to cut the convex side of the rail at P; take the length around from V to P, and apply it on the base line from Y to E and X to R. Raise plumb lines from E R to cut the top of the falling mould;—these are the centre heights of the falling mould, to be applied to the centre heights of the face moulds. The dotted lines in the elevation show the outside falling mould—the heights for the outside falling mould being always the same as for the inside falling mould; the only difference in laying the former down is by taking the stretch-out of the concave side of the rail, and placing it on the base line as indicated by the dotted lines *s*, *s*.

TO FIND THE FACE MOULD.

At fig. 3 let S represent the semi-plan *z*, *z*, the chord line drawn parallel to the dotted line, to touch the lowest corner of the rail piece, from the centre of each end of the rail piece; raise the lines D, F, to an indefinite length, perpendicular to the chord line *z*, *z*; also, draw a line from the centre O perpendicular to the chord line. Take the heights D, I. E, K. F, L. from fig. 2, and apply them to the lines D, E, F, fig. 3; draw a line through the two outside heights at I, L, which will be the pitch-line of the face mould. Set the compasses in the centre height and describe a circle to touch the pitch-line; bring down the dotted tangent line to S to cut the chord line. At *o* draw a line from *o* to *e*; draw a line through the centre height at K perpendicular to the pitch-line; take the length of the line *o*, *e*, at S, and cut off the length of the line *t*, *e*, on the face mould; draw a line from *e* to the point *o* where the centre height cuts the pitch line—this line will be the governing ordinate. Take the length of this ordinate with the compasses, and with *e* in *s* as a centre, describe a segment to cut the chord line at *o*; draw a line from *o* to *e* for the governing ordinate; draw any number of ordinates parallel to the governing one, and where they cut the convex side of the rail piece S at *a*, *b*, *c*, *d*, *e*, *f*, *g*, *h*. Carry up lines to cut the pitch-line at R, *l*, *m*, *n*, *p*, *r*, *i'*, and bring them down to cut the concave side of the rail piece S, from the points R, *l*, *m*, *n*, *p*, *r*, *i'*; raise lines parallel to the governing ordinate; carry up the two corners *i*. 1, and the point 7 of the rail piece S, to meet the pitch-line; from

thence draw lines parallel to the other ordinates. Take the lengths of the ordinates in the rail piece S, and apply them to the corresponding ordinates from the pitch-line, and through those points trace the convex side of the face mould; make *b* 2, *c* 3, &c. on the face mould equal to *b* 2, *c* 3, &c. on S, and through those points draw the concave side of the face mould. Draw a line from *i* to *h*, and 1′ to *a*, for the ends of the face mould. This, and the preceding face moulds are drawn with the plank sprung.

Fig. 4 shews the method of getting the pitch of the face mould for the upper wreath, the spring of the plank, &c. when it is to be struck with the ellipsograph. The pitch heights A G, B H, C, correspond with those of the inside falling mould, from which as in all cases they are taken; the spring bevel shown in the semi-plan exhibits plainly how the spring is obtained; although it is obtained different from fig. 3 in plate 5, it will be found sufficiently correct—as it has a tendency to make the spring greater, in consequence of the convexity of the face mould being farther from the chord line than the semi-plan; but in all cases where the easings in the falling mould are not great, the difference can scarcely be perceived.

PLATE V.

TO FIND THE FALLING MOULDS FOR EXECUTING A HAND-RAIL FOR A STAIRS WITH EIGHT WINDERS, THENCE TO FIND THE FACE MOULD.

Fig. 1, the plan of the rail. Find the stretch-out of the convex side of the rail, and place it on any base line at fig. 2; carry up a line from the stretch-out points at S, S, perpendicular to the base line; set in a pitch-board of a straight step, both top and bottom; outside the stretch-out line S, S, draw a line from one pitch-board to the other, ease off the angles, and draw a line parallel to the bottom for the top of the falling mould; square off the ends

inside the plumb lines at A and F; carry up the centre line to cut the top and bottom of the falling mould; bisect the centre line at 1, 2 in *o*, and through *o* draw a line at right angles to the falling mould. Bring down lines from the points D, 4 to touch the convex side of the rail fig. 1, and then draw them to the centre; the distance those lines are from the centre line allow for making the joint. Draw the dotted chord lines on the plan, and parallel to them draw lines to touch the lowest corners of each rail piece—those lines will be the bases from which the face moulds are to be elevated. Draw lines from the centre of fig. 1 at right angles to the chord lines to cut the convex of the rail at 5, 5, place the distance from the diameter around to 5, on the base line from S to H, and raise plumb lines from the points H, H, to cut the top of the falling mould at B and E—then the points A, B. C, D. E, F. will be the heights for the pitch heights of the face mould.

TO DESCRIBE THE FACE MOULD FOR THE UPPER WREATH.

At Fig. 4 let K represent half of the plan of the rail; raise lines perpendicular to the chord line from the points *s*, *s*, *t;* let D, D be the lower height, B, B the middle height, and A, A the upper height of the face mould, carried over from the falling mould, as shown by the dotted lines. Draw a line in fig. 4 from A to D; take the centre height at B as a centre for the compasses, and describe a circle to touch the pitch-line A, D; bring down the tangent dotted line *o*, *o*, to cut the chord line of K at *o;* draw a line from *o* to *c;* draw a line through the centre height B at right angles, to the pitch line A, D; take the length of the line *o*, *c* in K, and place it on the line *o*, *c* from the pitch-line A, D. Draw a line from *c* to 3, where the centre height cuts the pitch-line, and it will be the regulating ordinate. Take the length of the regulating ordinate with your compasses, and with *c*, in K, as a centre, describe a segment to cut the chord line at 3; draw a line from 3 to *c*, and it will be the regulating ordinate for the semi-plan K; draw the ordinates *i*, *k*, 1, *a*. 2, *x*. 7, *g*. and 8, *h*. parallel to the regulating ordinate, and draw any number of intermediate ordinates; carry up lines perpendicular to the chord line from the points 1, *k*, *x*, *a*, *b*, *c*, *d*, *e*, *f*, *g*, *h*, to cut the pitch-line at 1, 1′, 2′, 2, 4, 5, 6, 8, and bring them down to cut the concave side of the rail at *u*, *u*, *u;* draw a line parallel to the chord from the point *u*, *u*, *u*, to cut the ordinates at *p*, *q*, *r*, from the points i, 1′, 2′, 2, 4, 5, 7, 8, on the pitch-line. Raise lines to an indefinite length parallel to the regulating ordinate 3, *c;* take the length from *i* to *k* in K, and place it from *i* to *k* on the pitch-line, also take 1, *a*. 2 *b*, 4 *d*, 5 *e*, 6 *b*, 7 *g*, and 8 *h*, in K, and from the

pitch-line cut off the lengths of the corresponding ordinates; through those lengths draw the convex side of the face mould; take the length of the ordinate 2 *x*, in K, and apply it to 2 *x* from the pitch-line; take the lengths of the ordinates from the convex side of the rail in K, as *b p*, *c u*, *d q*, *e r*, and apply them from the convex side of the face mould at *b p*, *c u*, *d q*, *e r*, then through the points 1, *x*, *p*, *u*, *q*, *r*, *g*; trace the concave side of the face mould, draw a line from *g* to *h*, and from 1 to *k*, and the face mould will be completed—the line *a x* shows where the curved part of the face mould joins the straight part.

Fig. 3 shows the pitch-heights for the upper wreath resting on the same base line as fig. 4; fig. 3 also shows the governing ordinate, the pitch, and spring bevels. To find the spring bevel, draw any line as the dotted line *a b* at right angles to the pitch line, to cut the dotted line *c d*; the line *c d* is drawn parallel to the pitch-line to touch the back of the face mould, as shown in fig. 5; take the radius of the circle drawn from the centre height at B, and with *a* as a centre, describe a segment to cut the pitch-line, then draw a line from the intersection to the point *b*, and it will be the spring of the plank. The governing ordinate is obtained in the same way as already described for fig. 4. The lines in fig. 3 show all that is necessary when the face mould is to be struck with an ellipsograph.

Fig. 5 exhibits the face mould for the lower wreath, with all the principal lines, bevels, &c. on it, duly explained. The pitch-heights G C, H E, I F, are taken from the corresponding heights on the falling mould.

PLATE VI.

TO DRAW THE FALLING MOULD FOR AN ELLIPTIC STAIRS, THENCE TO FIND THE FACE MOULDS.

The plan Fig. 1, shows the ends of the steps diverging from the rail, which are equally divided around it and the wall. To find the inside falling mould, take the steps around on the convex side of the rail, from *c to b*, the conjugate diameter, and stretch them out on the base line at fig. 5, from *c* to *b*; set up the height rod with the number

of risers there are on the plan fig. 1; draw the top of the last riser in to meet the stretch-out line *b* at *s*. Set up one riser on the lower stretch-out line *c* at *s*, join *s s*, by a line and produce it to the base line at *y*. Take the distance from *c* around to *a* on fig. 1, and place it on the base line from *c* to *a*, and ease off the angle as shown; by intersections of lines, produce the line *s s*, to an indefinite length at the top; set up the height of the rail on the level landing, the height required to meet the return flight, or if the rail is to terminate on the level landing, as is intended in this case, make it rather higher; draw the level part of the rail out to meet the line *s*, *s*; ease off the angle, and draw a line parallel to the bottom, which completes the inside falling mould. The outside falling mould is obtained from the same heights—the only difference is by taking the stretch-out of the concave side of the plan of the rail for the base line, as shown in the preceding plates. Determine on the joints in fig. 1 for the number of pieces the rail is to be formed of—(in this case they are three); then draw a chord line from the centre of each joint, and parallel to them draw another line to touch the lower corners of the rail pieces; take the stretch-out on fig. 1 around from the centre line *o* to the joints, and lay them out from the centre *o* on the base line fig. 5. Raise lines from those points perpendicular to the base line to cut the top of the falling mould. Bisect those lines where they cut the top and bottom of the falling mould, and through the centre draw lines at right angles to the falling mould; bring down lines from the corners of the joints in the falling mould to the base line, and those lines will be the heights to apply from the chords for the pitches of the face moulds.

To draw the face mould fig. 2, raise lines perpendicular to the chord line in fig. 1, from the centre of each end of the rail piece; take the heights A C, B D, in fig. 5 of the falling mould, and apply them to the heights A C, B D, for the face mould; draw a line through the heights at C, D, which will be pitch-line; raise any number of lines perpendicular to the chord line to cut the pitch-line, and at the points where they cut the pitch-line, raise lines perpendicular to the pitch-line; take the lengths of the ordinates from the chord line to the concave and convex sides of the plan, as 1, 2, 3, and apply them to the corresponding ordinates 1, 2, 3, for the face mould; through those points trace the face mould. It will be observed that this face mould is drawn different from the preceding ones—the plank not being sprung, which is not necessary in this case, the part of the falling mould that fig. 2 is taken from being quite straight. The more easing or curvature there is in a falling mould the greater is the advantage derived from springing the plank, as it is not only a

saving of material by taking a plank of less thickness, but considerably diminishes labor in the execution of it. Figures 3 and 4 show the face moulds for the other sections of the plan with the plank sprung; the letters of the pitch-heights correspond with those of the falling mould, from which they are taken. The method of drawing those face moulds is precisely the same as the face moulds in the preceding plates, which has been repeatedly explained.

Fig. 6 shows the method of developing a small bracket from a great one, or, a greater from a lesser one. In this case let A be the given bracket for the step, and B the bracket for the winder; draw any number of ordinates at right angles to the top of A; determine on the length of B, and place it on any line drawn from the corner 2; draw a line *o p*, and parallel to it draw all the other ordinates from the ends of the ordinates touching the line *2 p;* draw lines at right angles to the line *2 p;* take the lengths of the ordinates on A, and apply to the corresponding ordinates on B, as 12, 43, &c. and through those points draw the form of the bracket B.

PLATE VII.

Figures 8, 9 and 10, show different sections of a concentric ellipsograph. To convey an idea of this instrument, let the reader suppose a pair of compasses opened to any radius: for example, to strike the semi-circle at fig. 1; then with that radius, lay one leg of the compasses on the centre line or axis of the cylinder, and moving them lengthwise, at the same time causing them to revolve on the bottom leg—the operation of the instrument will be immediately perceived. Fig. 10 is an end view, *x* the shaft which slides through the grooved piece *o*, and in which the stump is fixed for the centre of the arm 1 to revolve on; 2 shows the arm

1 in another position; 3 shows the upper part of 1 that contains the pencil slided out to strike a larger circle; *a*, screw to adjust the upper part to any radius; *b*, screw to keep the pencil firm. Fig. 8, top view with the arm that contains the pencil placed in a vertical position, at *p* shows the shaft *x* sliding out of *o*, *o*. Fig. 9, side view with the arm standing in a vertical position; 5 shows the pencil farther from the centre to strike a larger circle or the convex side of a face mould; 6 shows the arm 7 moved farther back. Fig. 7 shows the method of constructing an ellipsograph in the most simple manner and which will answer for every purpose to which it is applicable. Let *a a* represent a piece of wood one inch square and any length, say three feet; *c*, *c*, *c*, *c*, blocks screwed, or nailed down on the bench or drawing board, between which the strip *a*, *a*, is to easily slide; S a stump fixed in *a*, *a*; *v*, a piece of wood one inch square, which revolves on the screw fixed in the stump S; *i*, shows a pencil placed in *v*, equal from the screw to half the shortest diameter of the curve it is to strike; *h* shows the pencil placed in another hole, the thickness of a rail farther from the screw, to strike the convex side of a face mould. The application of fig. 7, is shown in the next plate.

Fig. A, shows six different sections of a semi-cylinder standing on the same base, struck with an ellipsograph. Fig. 1, a section cut at right angles to the axis of the semi-cylinder, and consequently a semi-circle. Fig. 2, a section cut in the direction *a*, *b*, and at right angles to the plane passing through its axis, produces a semi-ellipsis—*a b* being its conjugate diameter, and *o*, *o* its transverse radius; fig. 3 a semi-ellipsis also, but its conjugate diameter greater than that of fig. 2. Fig. 4, a section of a semi-cylinder cut in the direction *e*, *f*, on a plane passing through its axis, and making an acute angle with that plane. This section and the succeeding one shows the method of springing the plank for hand-rails. To present a simple and correct view of those sections, the reader will suppose the whole of the figures to be cut around their curves, and turned up on the lines of their different sections in an erect position. For example, take fig. 1, and cut through the paper around the circle, and turn it up at right angles on the diameter line; also, figs. 2 and 3 in the same manner at right angles. Fig. 4 must be turned up and the top of the curve at *x* come plumb over the dotted line *s*, *s*. This section makes an acute angle with the axis plane. Fig. 5 must be turned up until the top of the curve at *m* is plumb over the dotted line *u*, *u*; this section makes an obtuse angle with

the axis plane. Fig. 6 is a section cut in the direction *i i*, and making an acute angle with the axis plane, the top of this figure must be turned towards the base until its height corresponds with the radius of the base. When those sections are placed in the positions as described above, the reader will plainly see, that every part of their curves are on a line with each other, and of equal radii from the centre line. The importance of this simple instrument, the concentric ellipsograph, and the facility of its application to the obtaining of the section of a cylinder in any direction whatever, is plainly depicted in the various sections on fig. A. The advantages this instrument has over that of the ordinary trammel, are, that it only requires to be set once—viz: *to the radius of the shortest diameter of the curves it is to strike*, to obtain the various curves in a niche, groined ceiling, dome, face mould for a hand-rail, &c. the angle which the objects make with the axis of the instrument whilst being struck produces their conjugate diameters.

PLATE VIII.

TO OBTAIN THE FACE MOULD FOR A HAND-RAIL WITH AN ELLIPSOGRAPH.

In fig. 3 let *c, e.* 5, 3. be the pitch-heights of A, plate 2 and *d* 4 the centre height; fix the instrument on the line of the centre height as *g g;* place a block on each outside height 3, 5, and against those blocks fix the board *a a*, the bottom edge of which must be the same distance from the centre of the instrument that the chord line is from the centre on the plan as *d k;* place the pencil in the arm *i*, the same distance from the centre that the inside of the rail is from the centre on the plan as *o k;* take the arm *i* in your hand and make it revolve, at the same time keeping the point of the pencil in contact with the surface of the board *a, a*, and mark the concave side of the mould, move the

pencil the width of the rail farther from the centre, and draw the convex side of the mould. The dotted lines at F show the board turned down in a horizontal position with the lines on it as struck with the instrument. Take the length of the pitch-line from 5 to 3 on the edge of the board, draw a line from the point 5 to touch the curve line *xx*, and parallel to it draw another to touch the line at *x*—this will be the tangent part of the rail. Carry up lines from the corners of the plan *s*, *s*, to cut the pitch-line, and from their intersection raise lines at right angles to the pitch-line, and where they cut the convex side of the rail at *w*, *w*, draw lines to the inside corners of the mould, which will give the cut of the ends of the face mould; *m* shows the arm moved round towards the straight part of the face mould. It will be observed, that in this case the plank is not sprung, as the board for the face mould is fixed quite plumb for it to be struck with the instrument.

Fig. 2 shows the elevation of fig. 3, with the board placed on the blocks in its right position, on which the face mould is to be struck.

Fig. 1 shows the pitch heights of the upper wreath of plate 3; *x*,*x* the board for the face mould; *o* the square showing that the plank is not sprung; *c* the pencil, always placed in the arm from the centre *d*, equal to the inside and outside of the rail on the plan. Where the easings in the falling mould are not great, it is of no importance to spring the plank, as in the two last cases. What has been said of the method of finding the face moulds in the two last figures will apply to every variety of face moulds when the plank is not sprung.

TO DRAW A FACE MOULD WHEN THE PLANK IS SPRUNG.

Figure 4. Let A G, B H, C, represent the pitch-heights of fig. 4, plate 8; *x*,*x* the bottom edge of the board for the face mould; take the spring bevel shown at B, and place it against the back of the board *x*, *x*, so that the top of the board, when equal to the width from the pitch-line to *p*, will be plumb over the dotted line *o*, *o;* then draw the face mould with the instrument as already described for fig. 3; the distance of the line *o o*, from *s*, is equal from *s* to H. It is necessary for the top edge of the board to stand out of plumb equal to the spring bevel from the centre pitch-height for it to be struck, so that the ends of the twist will be thrown down or up, as the case may be, to suit the curvature of the falling mould.

TO DRAW A FACE MOULD WHEN THE PLANK IS SPRUNG.

Fig. 5. Let the line *a a*, be the bevel or pitch-line of fig. 5, plate 5, and let the board for the face mould be set over this line, the bottom edge of which must always be the same distance from the centre of the instrument, that the chord line is from the centre on the plan, and let the board rest against the bevel C when it is turned up, with its stock resting on the bench; place the pencil in the instrument the distance from the centre equal to the radius of the concave side on the plan, and draw the concave side of the mould; move the pencil the width of the rail from the centre, and draw the convex side; draw the tangent part of the rail as directed, for fig. 3. To cut the joints of a face mould when the plank is sprung, let the two concave corners of the mould when cut out, rest on the points *i i*, and the back side of the mould rest against the bevel when it is turned up with its stock on the bench; then cut away the ends of the mould until its convex and concave corners are plumb over the corners of the rail on the plan; the dotted lines *v*, *v*, *v*, &c. show lines carried up from the corners of the rail on the plan, as shown from fig. 6.

THE METHOD OF FINDING THE THICKNESS OF STUFF FOR THE TWIST OF FIG. 5, PLATE V.

Figure 6. Let A represent the semi-plan of the rail. Carry up plumb lines from the chord line 1, 2, 3, 4, 5, 6, three sections of the semi-plan, 1, 2, and 5, 6, being the ends of the rail, and 3, 4, the middle section on the diameter line, where the easing always occurs; take the heights from the falling mould F, *f. o s*, and C 4, on fig. 2, plate 5, and apply them to the corresponding heights on fig. 6, plate 8, and from those heights draw the three sections of the rail *a*, *b*, *c*,—the space those sections occupy between two parallel lines is the thickness of stuff required for the wreath when the plank is not sprung, which is six inches, the rail being three inches wide by two and three-fourths thick. The thickness of the stuff required when the plank is sprung, as in this case, will be equal to the length of the dotted line shown on the section *b*, which is four inches. By this method the thickness of stuff required for any twist can be obtained.

APPLICATION OF THE MOULDS TO CUT OUT THE TWIST.

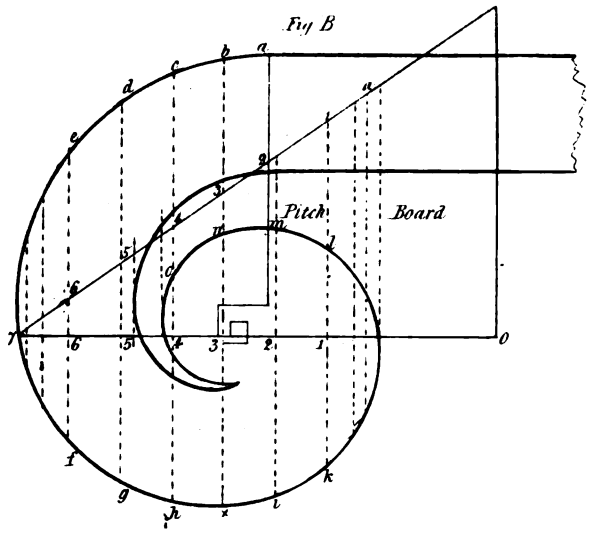
Commence by making the edge of the plank straight and square, if the plank is not sprung, but if sprung, the edge must be beveled to suit the spring bevel; then lay the face mould with its corners on the concave side, on a line with the edge of the plank, and mark the form of the face mould on the plank; from the corners of the face mould, draw lines across the edge of the plank with the pitch bevel, and from those lines lay down the face mould on the other side of the plank, and draw its form; cut the plank through to those lines, and dress accurately to them the piece for the twist. Then take the inside falling mould, and bend around on the convex side of the rail piece, observing that the rail will square itself on each end from the concave edge of the falling mould, and from one side of the plank, let the extreme ends of the falling mould be even with the plumb cuts of the rail piece; then mark its form on the rail piece; draw square lines from the extreme ends of the falling mould across the plumb cuts, and apply the concave falling mould to those lines; then mark its form on the rail piece; cut away the superfluous wood on the sides to the lines of the two falling moulds, and the twist is squared. Cut off the ends of the twist to the convex falling mould and the shortest edges of the ends of the twist,—then the twist will be prepared to be moulded into the form required.

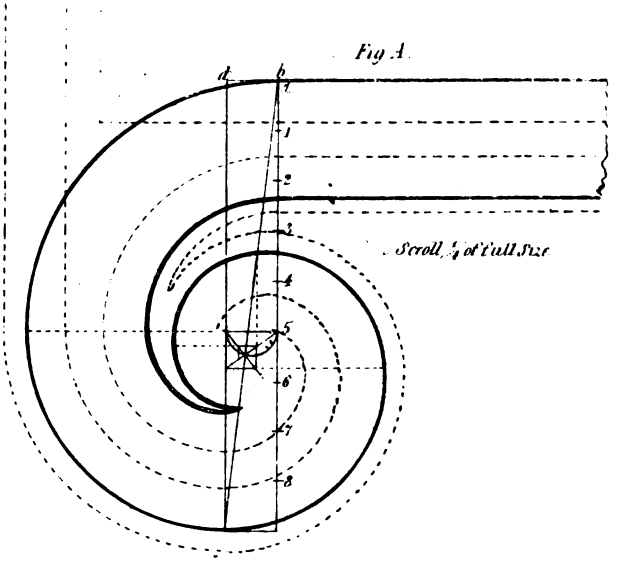
TO DRAW THE STRING.

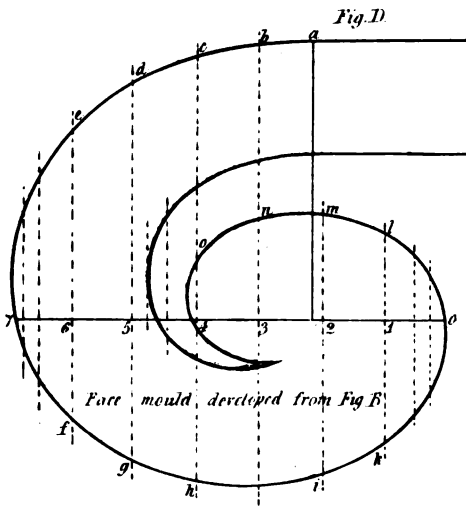
The mode of proceeding to obtain the easings on the lower edge of the string, is precisely the same as for the falling moulds, viz. by drawing the face of the string on the plan of the rail and stretching it out on a base line, then apply the same heights as for the falling moulds.

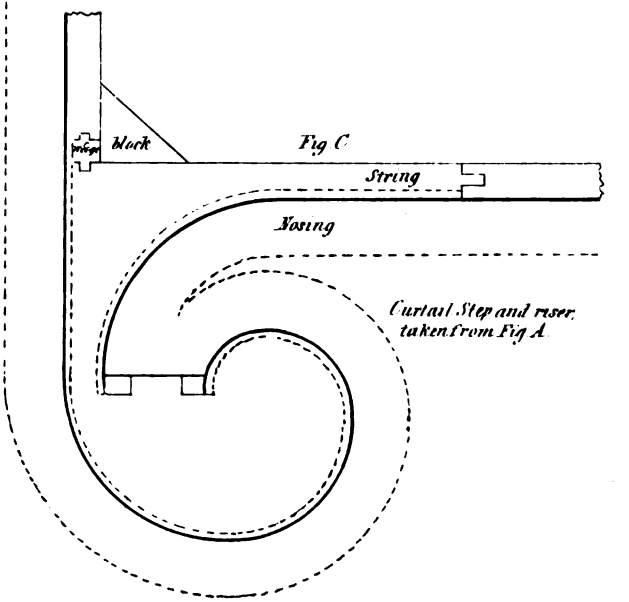
FINIS.

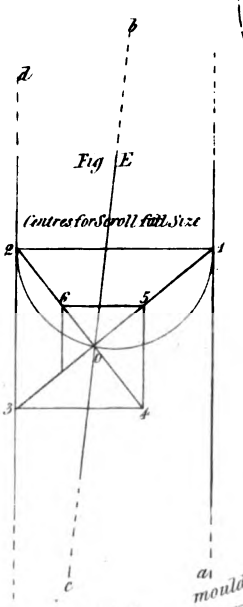
Plate I











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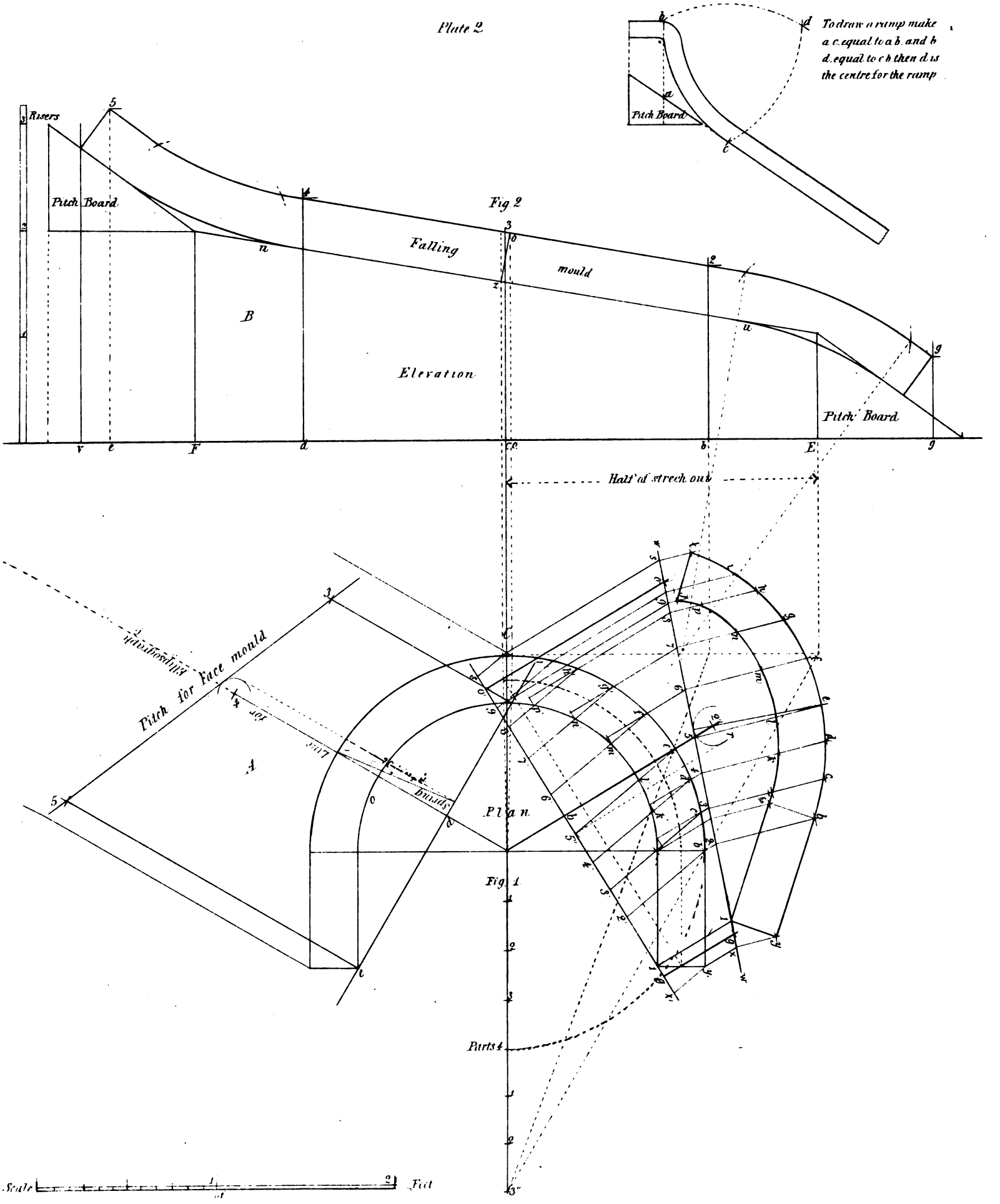

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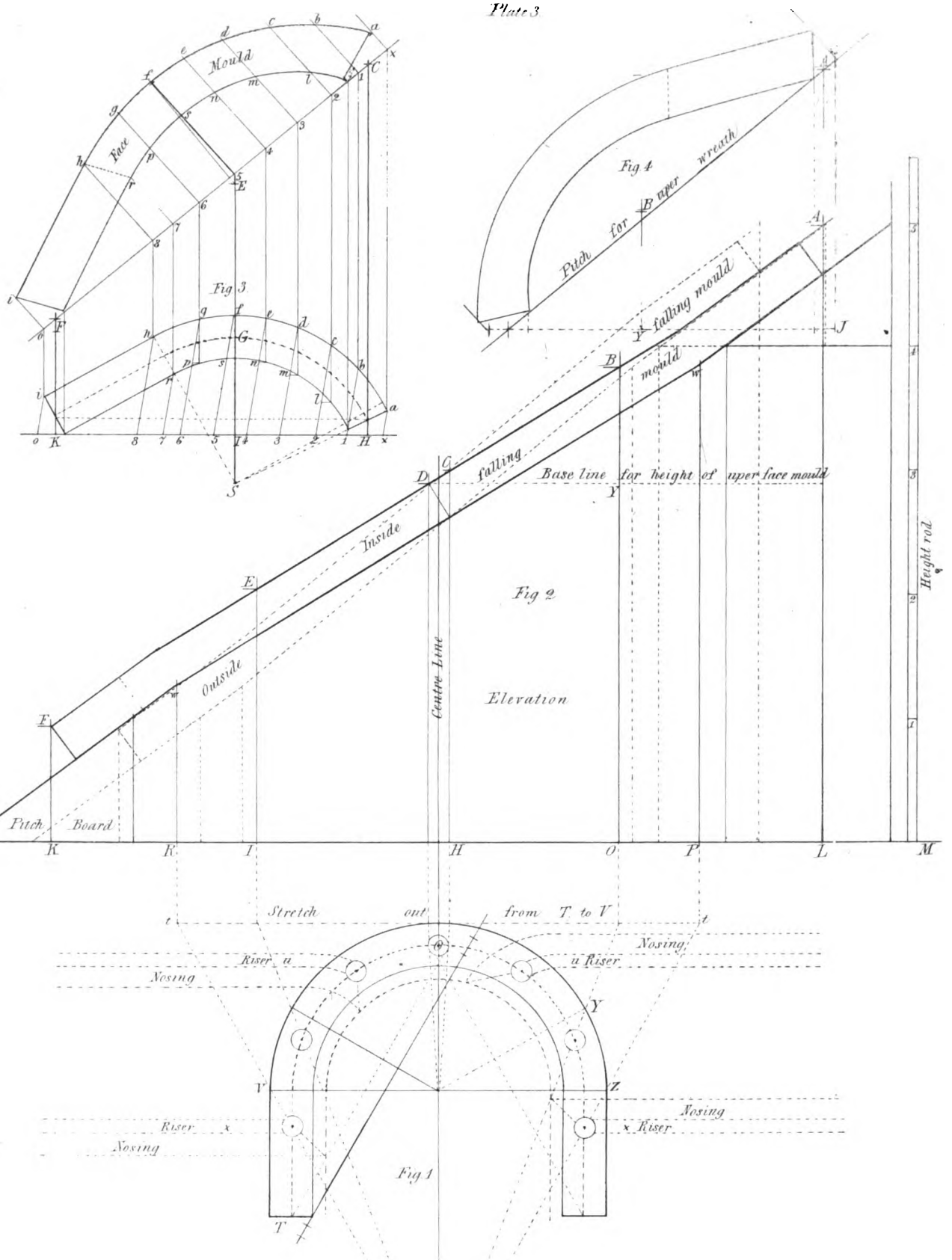

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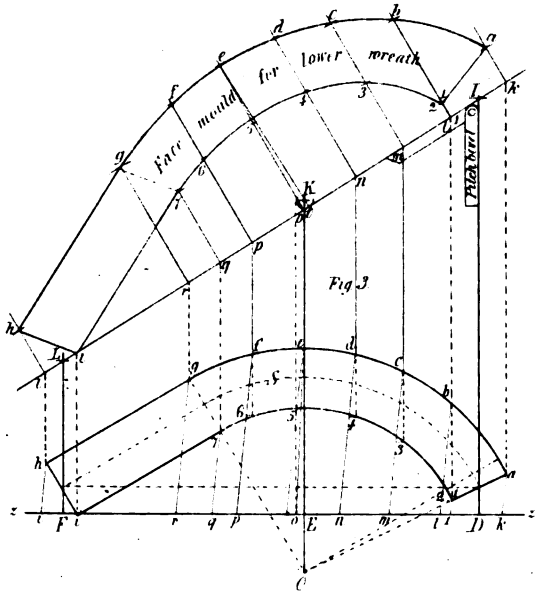

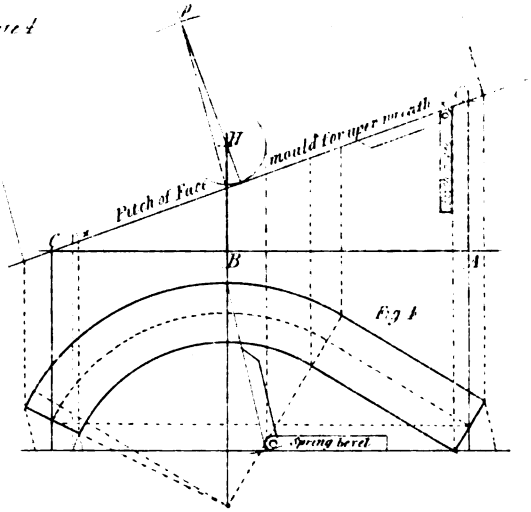

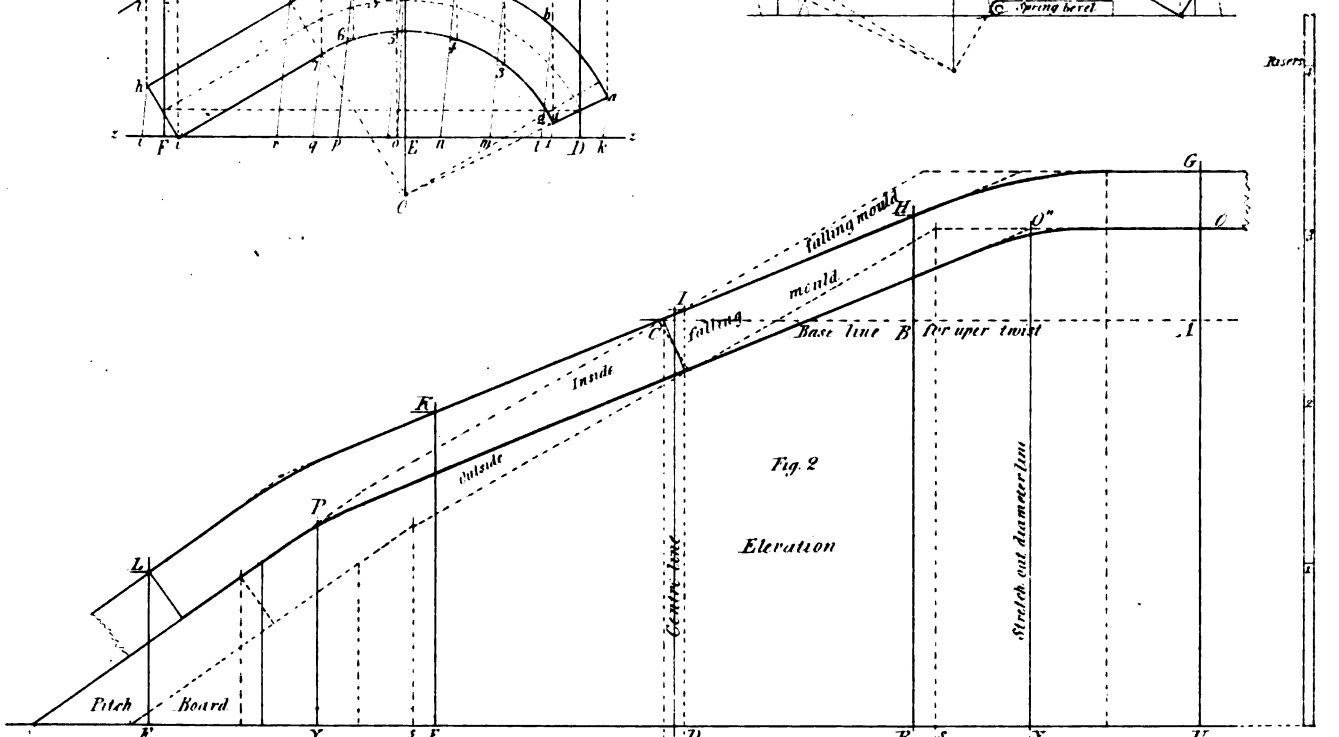

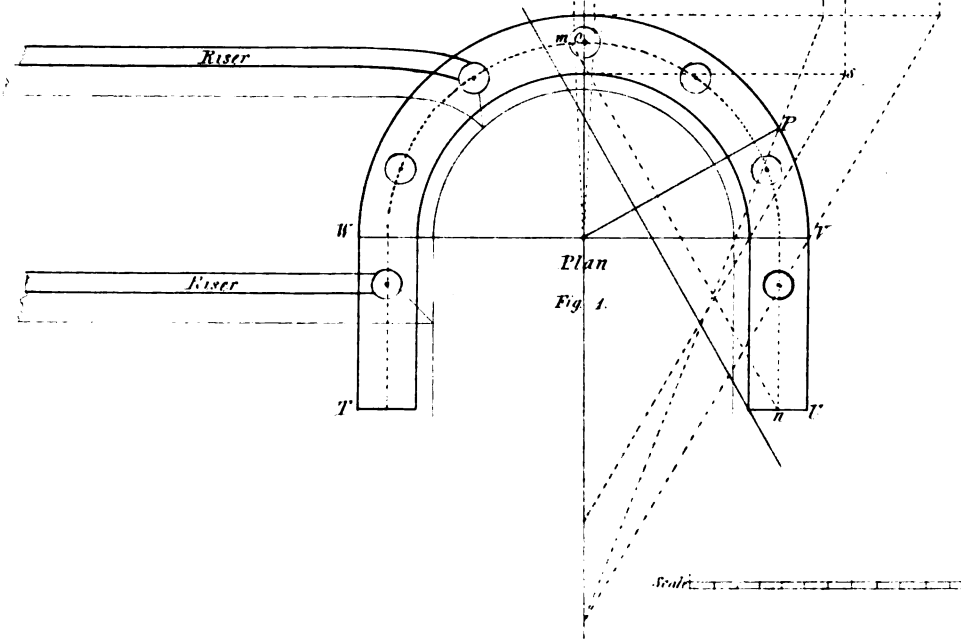

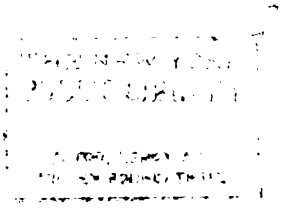

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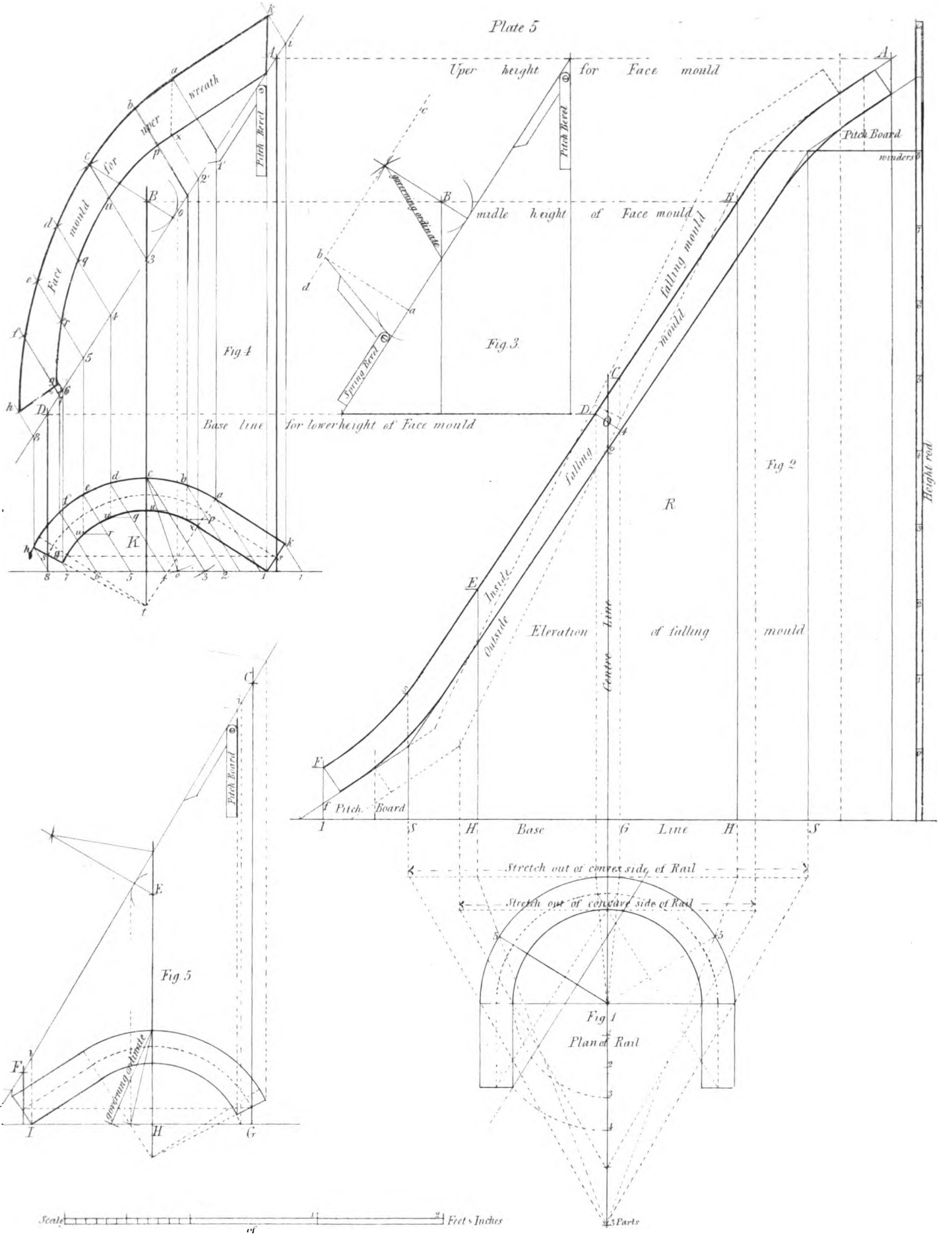

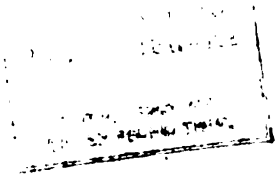

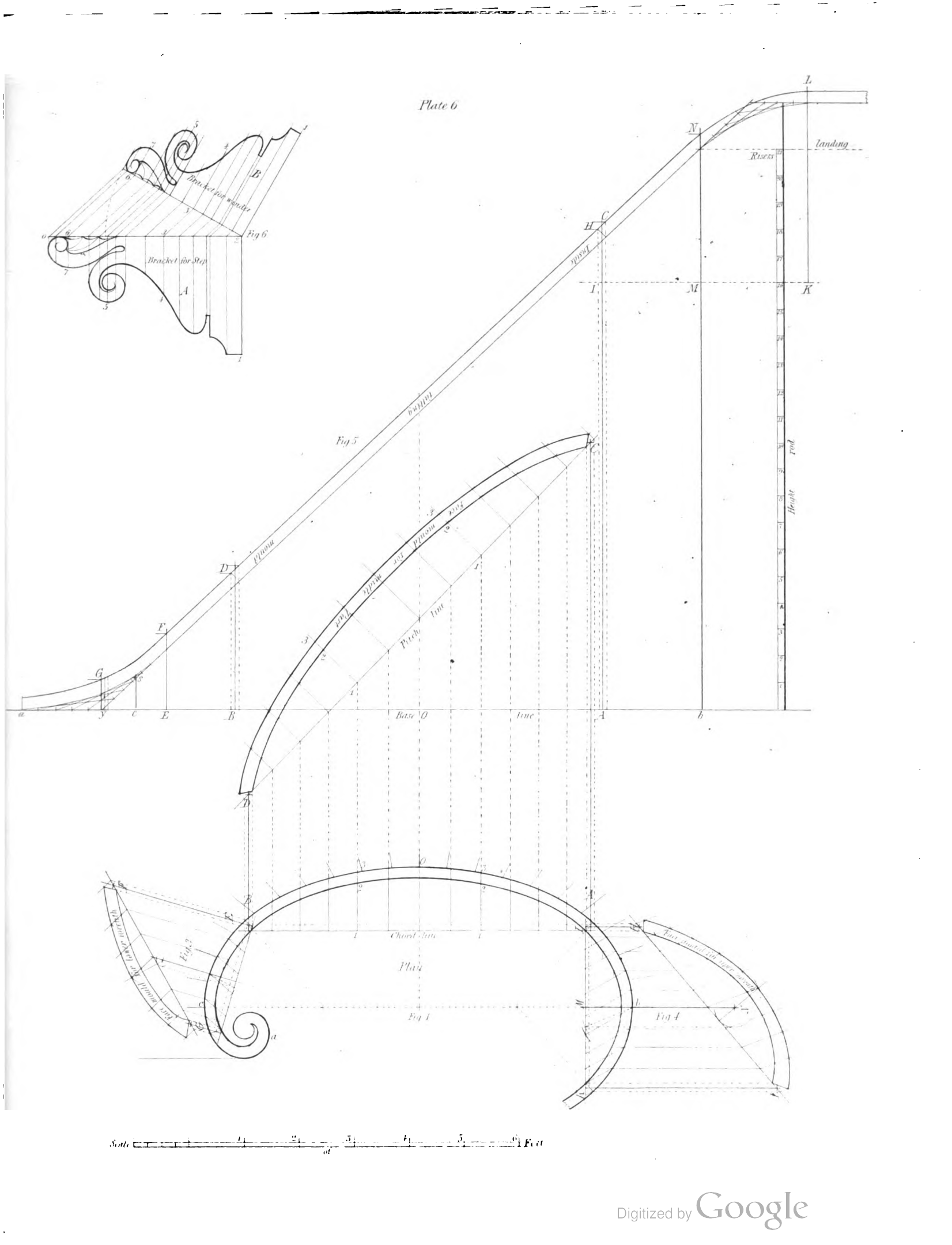

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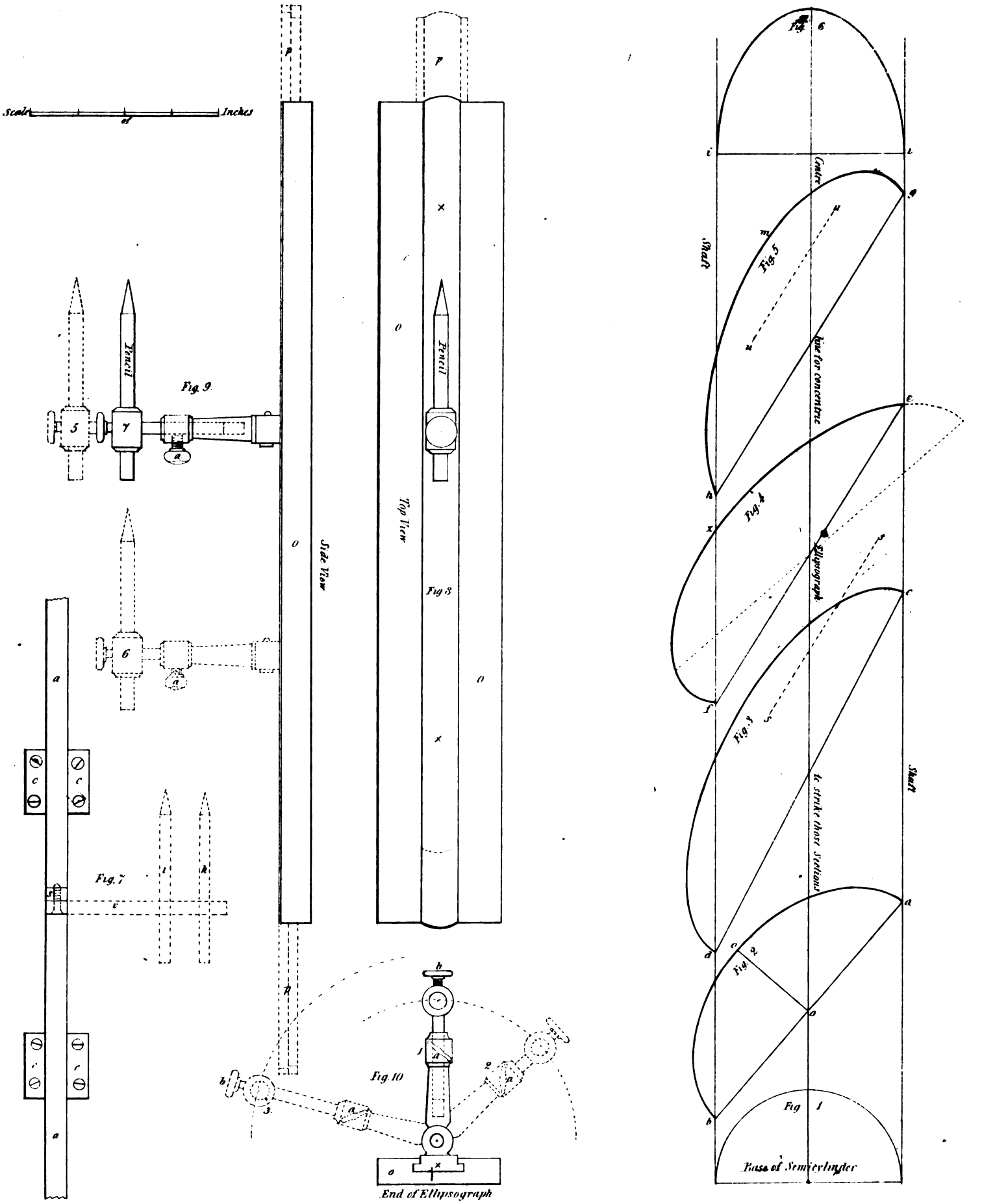

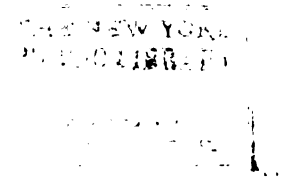

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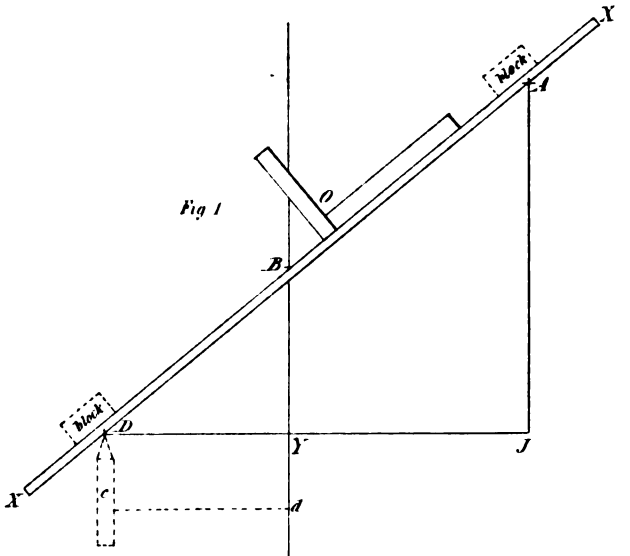

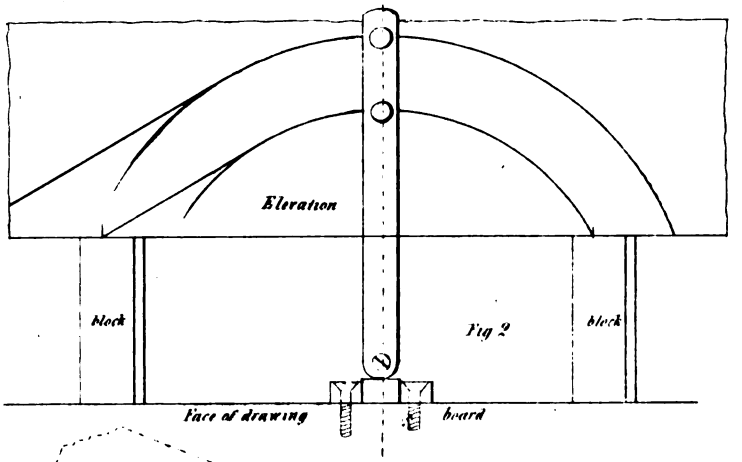

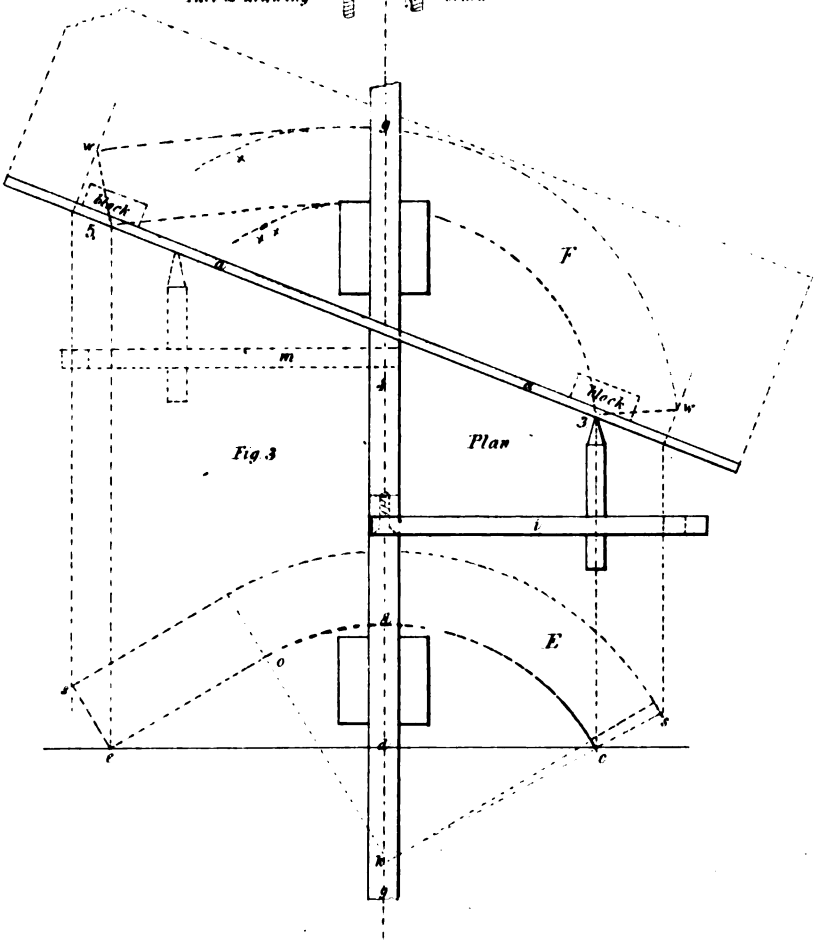

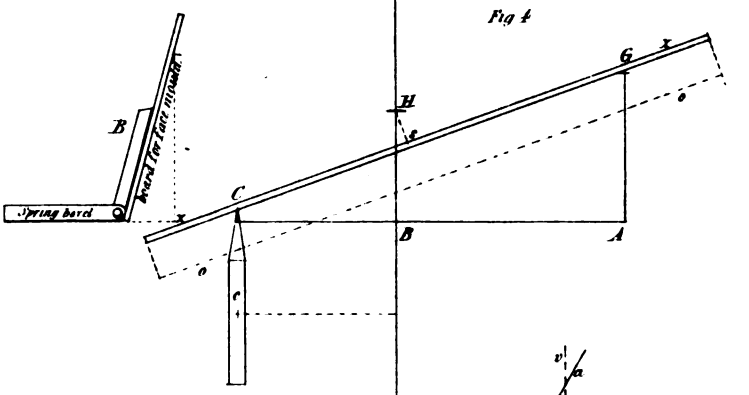

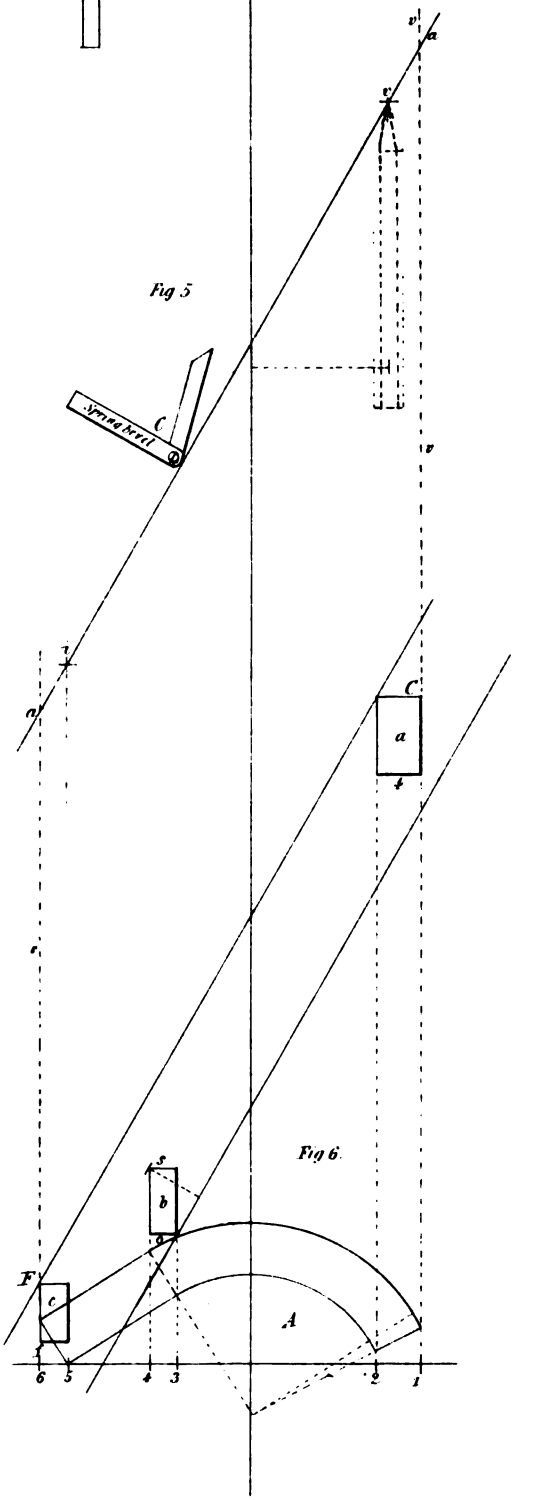

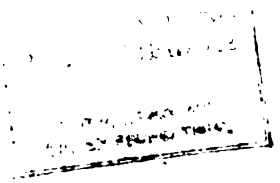

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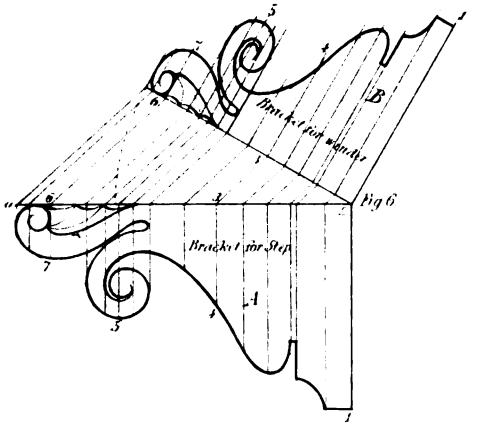

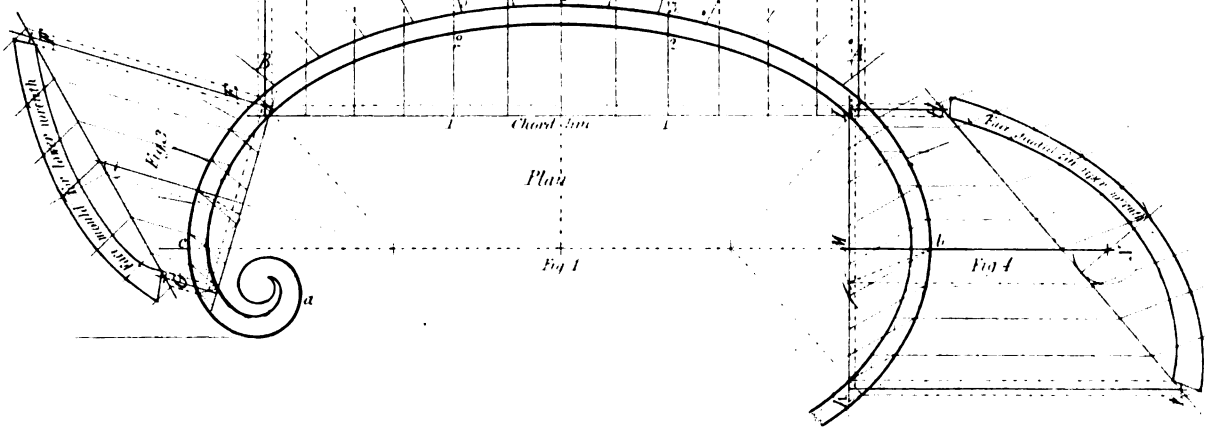

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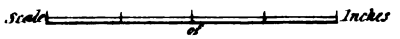


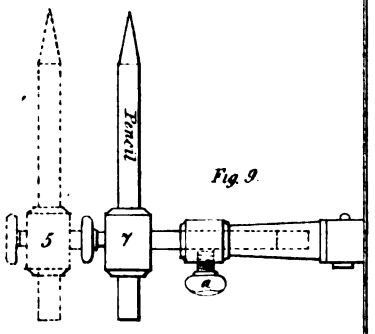
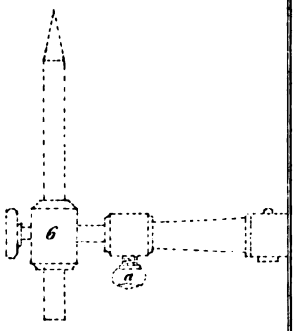


Fig. 9.



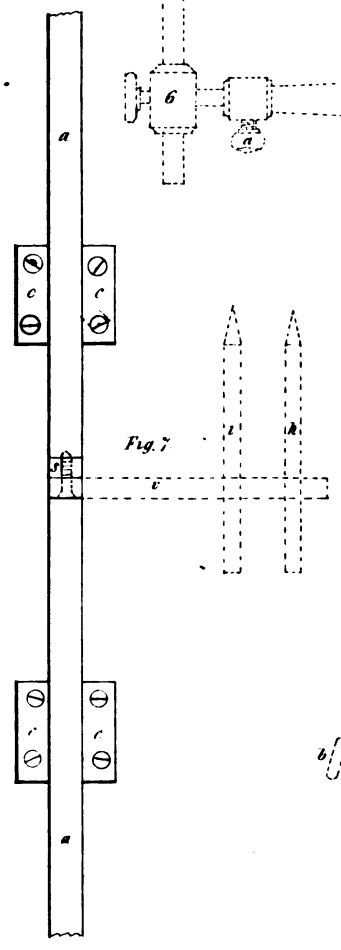
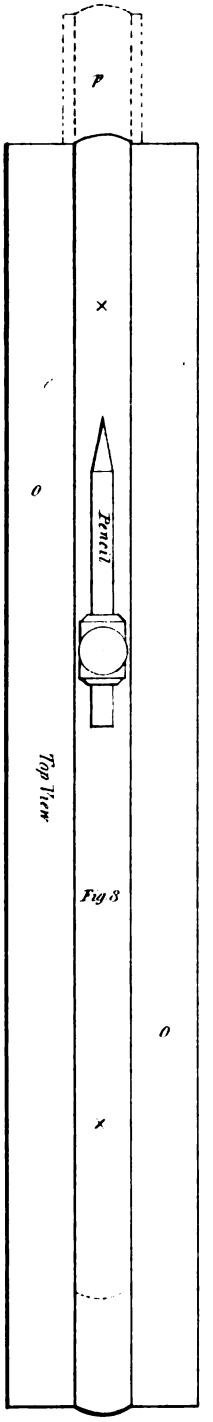


Fig. 7

Side View



Top View

Fig 8

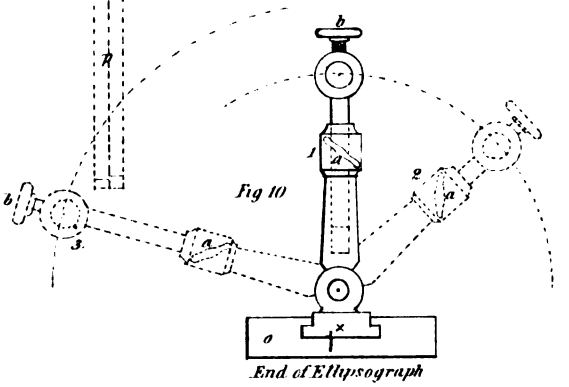
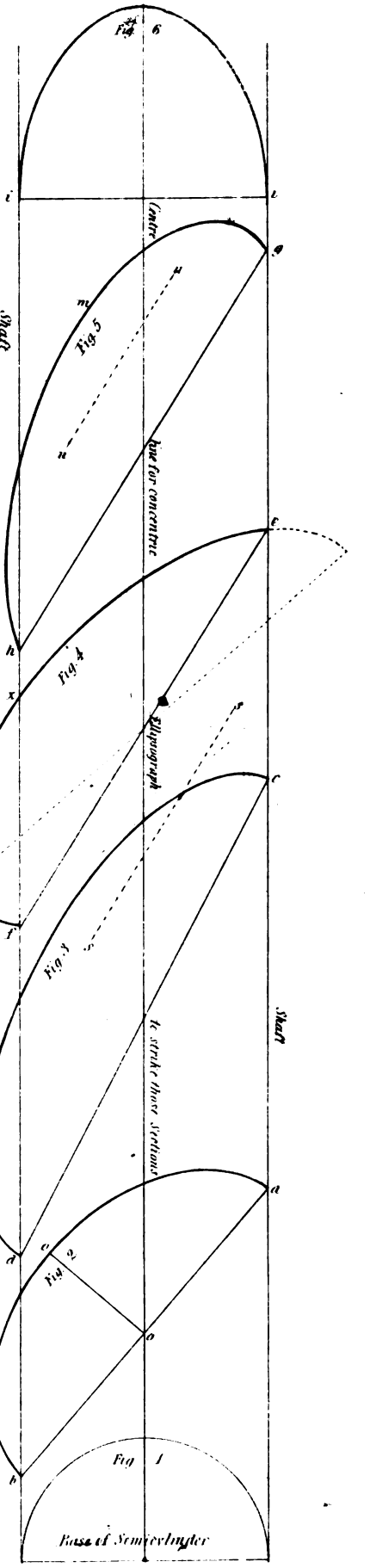


Fig 10

End of Ellipsograph



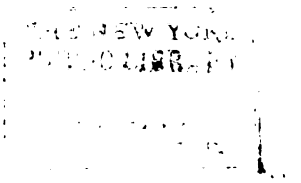


Plate 8.